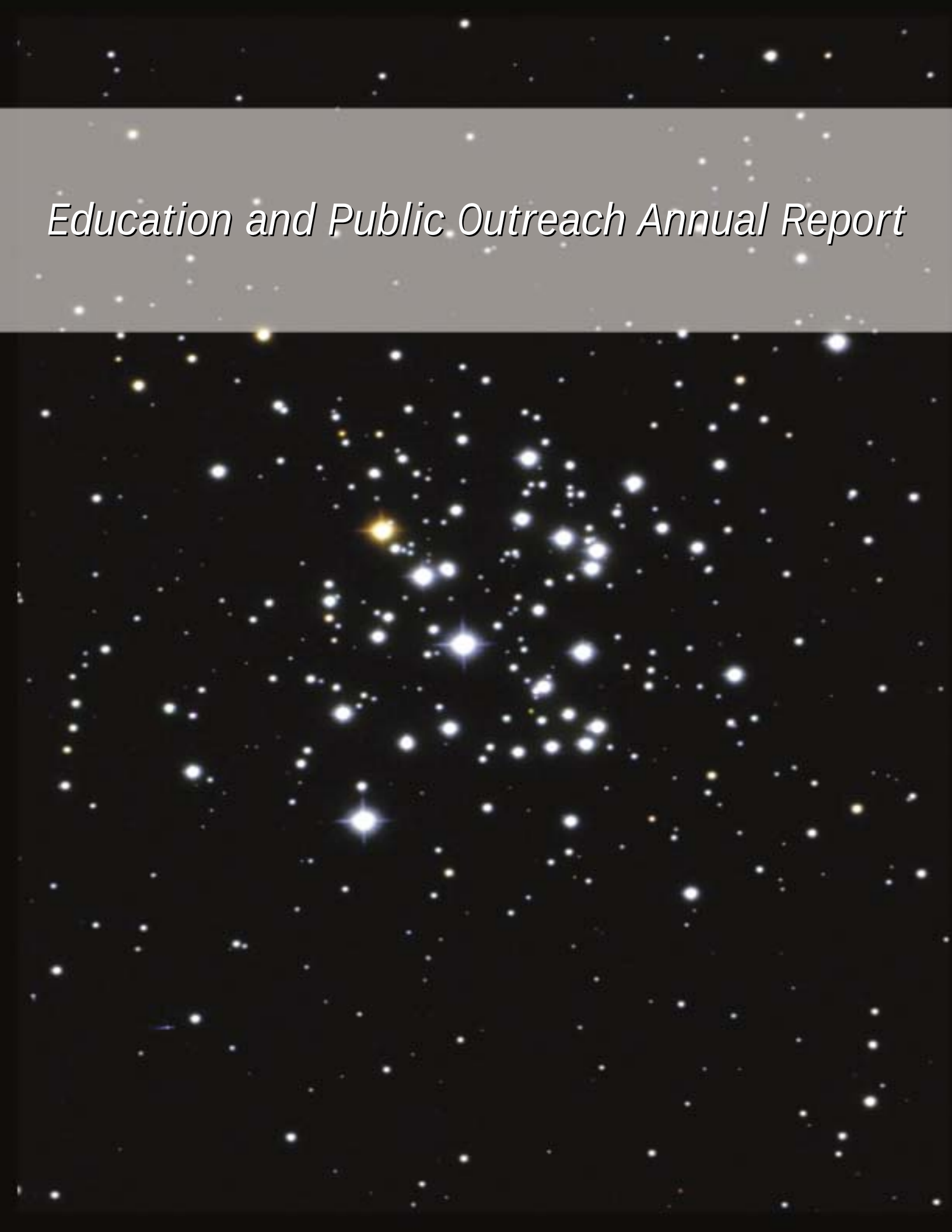
Education and Public Outreach Annual Report



"It will be the total effect of a broad ensemble of high-leverage activities carried out over a long period of time which can make a difference."

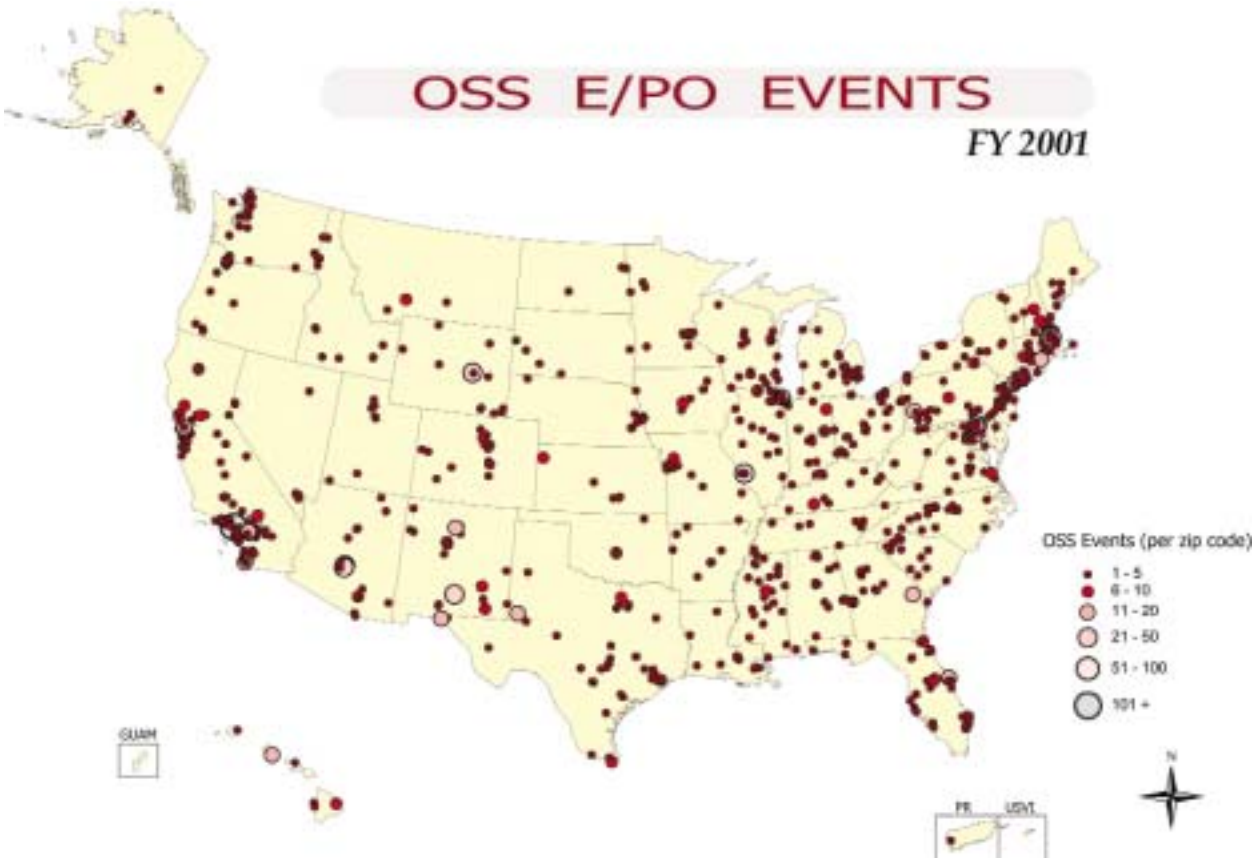
—Implementing the Office of Space Science (OSS) Education and Public Outreach Strategy (October 1996)

INTRODUCTION

This second Annual Report on the NASA Office of Space Science (OSS) Education and Public Outreach (E/PO) Program summarizes the hundreds of E/PO products developed and activities carried out during Federal Fiscal Year (FY) 2001 under OSS sponsorship. Examples of the products and activities covered include award-winning educational Web sites, major exhibitions in museums and science centers, partnerships with professional societies of minority scientists, an online directory of space science educational resources, research projects that allow students and teachers to participate in NASA space science missions, live Webcasts of total solar eclipses, and public television broadcasts on major space science research areas. Prominent among these activities is an emphasis on spreading the reach of the OSS E/PO Program to encompass an increasingly more diverse variety of participants, including rural communities and students with disabilities; and an emphasis on using organizations such as professional societies of minority scientists to reach out to audiences who previously have not been significant participants in the space science program.

In total, more than 400 E/PO products and activities are summarized in this report. Included are the following:

- over 90 new educational products developed during FY 2001;
- over 160 educational activities that directly supported classroom education;
- over 90 educational activities directed at reaching the public; and
- a variety of activities providing support to science centers and planetariums, encouraging members of the space science community to contribute to E/PO activities, emphasizing targeted outreach, or addressing special needs with the education community.



Nearly 3,000 E/PO events took place under OSS sponsorship in FY 2001, encompassing all 50 States, the District of Columbia, and Puerto Rico.

Taking into account the fact that many of the reported activities involved multiple events that took place in a variety of venues, the total number of E/PO events reported for FY 2001 is close to 3,000—almost twice the number reported in FY 2000. Events took place in all 50 States, the District of Columbia, and Puerto Rico. The estimated audiences for these events included the following:

- over 200,000 direct participants in workshops, community and school visits, and other interactive special events;
- over 50 million Internet participants for Webcasts, Web chats, and other Web events; and
- a potential audience of over 200 million participants for lectures, planetarium shows, museum exhibitions, conference exhibits, radio, television, and other forms of public media.

Complete information on each of these products and activities, including event dates, locations, and participant counts, appears in Appendix A. Summary comments and descriptions of some highlights are contained in the narrative below.

The OSS E/PO Program is one component of NASA's overall approach to education. It contributes to meeting the mandates of the NASA Strategic Plan to "involve the education community in our endeavors to inspire America's students, create learning opportunities, enlighten inquisitive minds," and to "communicate widely the content, relevancy, and excitement of NASA's missions and discoveries to inspire and to increase understanding and the broad application of science and technology." It is based upon the unique science being done by OSS—the results from its missions and research programs—and the unique capabilities of the space science community.

In FY 2001, more than 100 OSS missions and research programs contributed to the E/PO products and activities described in this Annual Report. Every OSS flight mission and research program is expected to devote a portion of its resources to E/PO efforts, and to include such E/PO efforts as an integral element of its overall program. This approach has created a highly diversified portfolio of E/PO products being developed and activities being carried out in conjunction with mission and research development activities in locations across the country. Adding to this portfolio are innovative space science E/PO programs developed under the *Initiative to Develop Education through Astronomy and Space Science (IDEAS)* Program, projects initiated under the *Minority University Education and Research Partnership Initiative in Space Science*, projects initiated or coordinated by the OSS E/PO Forums and Broker/Facilitators, and a number of additional comprehensive or special-purpose programs managed by OSS at NASA Headquarters. A directory of all the missions and programs that participated in developing E/PO products or carrying out E/PO activities in FY 2001, along with references to the specific E/PO products developed and activities

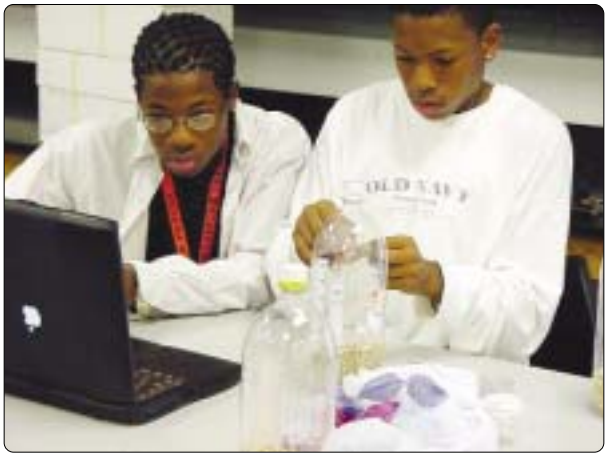
Nearly 500 institutions and organizations partnered with OSS to develop and implement E/PO programs in FY 2001.

carried out under each mission and program, appears in Appendix B.

OSS has made a major commitment to actively engage its community of space scientists in NASA's education efforts. Nearly 900 OSS-affiliated scientists, technologists, and support staff contributed to OSS E/PO products and activities in FY 2001. These individuals, who are OSS's most precious resource, shared their knowledge and expertise with the education community and with the public. By sharing the excitement of new discoveries and the stories of how those discoveries were made with teachers and students, they contributed to enhancing the quality of science, mathematics, and technology education across the Nation. By bringing to the public the knowledge gained from new discoveries, they contributed to increasing the public's understanding of science and technology. By exposing students across America to the excitement of space science early and often, they contributed to creating a 21st century scientific and technical workforce that will continue America's leadership in science and technology. OSS is grateful for their time and efforts and is pleased to list their names and affiliations in Appendix C.

The OSS approach to E/PO is based on building partnerships with the education community and other organizations engaged in education to create products and activities that meet the needs of educators and that use multiplier effects to reach as large an audience as possible. In FY 2001, nearly 500 institutions and organizations partnered with OSS to develop and implement E/PO programs. Included among them were nearly 180 science centers, museums, and planetariums; nearly 40 precollege education organizations, school districts and boards; and more than 60 science institutions and organizations. Also included were nearly 70 colleges and universities (24 minority institutions among them), 12 professional societies of minority scientists and organizations promoting minority participation in science, and nearly 120 libraries and community organizations. A full list of these partners appears in Appendix D.

Conferences provide an effective means of contact with organizations and individuals engaged in space science E/PO activities. In FY 2001, OSS had a substantial presence at approximately 70 national or regional scientific and education conferences. Exhibits, workshops, materials, and knowledgeable staff were present at such conferences, which provided significant opportunities to discuss space science E/PO resources, opportunities, and issues with conference attendees. These conferences included 20 national education and outreach conferences organized by groups such as the National Science Teachers Association, the International Technology Education Association, and the National Conference of Black Physics Students. Also included were 36 regional education and outreach conferences sponsored by groups such as regional library associations and State science teacher associations, as well as a dozen science conferences at which OSS encouraged scientists to more actively participate in E/PO activities. Appearing in Appendix E is a complete list of the conferences held in FY 2001, at which there was a significant space science presence.



At one of the many activities facilitated by members of the OSS E/PO Support Network, students at Chicago's Walter Payton High School follow online instructions for how to build a soda bottle magnetometer.

Coordination and integration of the many OSS E/PO efforts now under way are the responsibility of the OSS E/PO Support Network. The major elements of this Network are the theme-oriented Education Forums and the network of regional Broker/Facilitators. The Forums are charged with coordinating the E/PO efforts of OSS's individual space science missions and with helping them to make their discoveries and results accessible and readily available to the education community. The Broker/Facilitators are charged with facilitating the involvement of space scientists in education through creating partnerships with educators to carry out high-leverage E/PO activities. Each Forum is responsible for supporting missions within one of the four OSS research themes: the Astronomical Search for Origins and Planetary Systems (ASO), Solar System Exploration (SSE), Structure and Evolution of the Universe (SEU), and the Sun-Earth Connection (SEC).

Each Broker/Facilitator is responsible for serving space scientists and educators within a specific geographical region. Contact information for each of the Forums and Brokers/Facilitators and a partial list of the E/PO projects in which they were most substantially involved in FY 2001 are given in Appendix B. For the many other projects in which they played the background role of catalyzing, coordinating, and facilitating the E/PO activities of others—as well as coordinating the reporting of those activities for this Annual Report—the work of Support Network members is not explicitly mentioned, but is implicitly assumed and greatly appreciated.

Because the OSS E/PO Program emphasizes high-leverage approaches and extensive partnerships undertaken in a decentralized way, any attempt to compile information on all of the OSS E/PO products and activities is bound to be incomplete. The information contained here was compiled from information on new products registered in the Space Science Education Resource Directory and from data on activities entered into the OSS E/PO Tracking and Reporting System by the individuals responsible for each E/PO product or activity. This FY 2001 Annual Report should, therefore, be regarded as a representative—rather than comprehensive—compilation of OSS E/PO products and activities, although it should provide a more representative sample of products and activities than was the case in FY 2000. Since we know that there were products developed and activities carried out that were not reported, the statistical information provided continues to represent lower limits for the quantities reported.

The sections of this report that follow begin by providing information on the more than 50 awards and other forms of public recognition that the OSS E/PO Program received in FY 2001. They then go on to give statistical summaries and to describe highlights of E/PO projects taken from each of the following categories:

- Science Center Shows/Exhibits—planetarium shows and museum or science center exhibitions;
- Targeted Outreach—activities that provide substantial targeted outreach to underserved/underutilized groups;
- Educational Products—products designed for use in classrooms, for enhancing the public understanding of science, and/or for special interest groups; and
- Educational Activities—activities primarily intended to enhance formal classroom education, the public understanding of science, or the involvement of scientists in E/PO.

The examples of products and activities cited in this narrative represent just a few highlights from the rich portfolio of products and activities fully laid out in the appendices. The main body of the report concludes with a discussion of program evaluation and brief look at future plans for the OSS E/PO Program. Appendices and indices then provide comprehensive details on all OSS E/PO products and activities that were reported for FY 2001.

"Your site . . . presents an undeniable excellence . . . making it worthy of being publicly designated as an example to be followed and as a true knowledge and information source."

—CPSnet Web Awards

AWARD-WINNING PROJECTS

One measure of the success of the OSS E/PO Program is the more than 50 awards or other forms of public recognition for educational excellence that OSS E/PO products and activities received in FY 2001. The vast majority of these awards were for Web sites providing information on NASA space science missions and educational resources based on that information. Also significant was the growing number of major NASA awards recognizing significant contributions of individuals or groups both inside and outside of NASA to space science education. Examples of some of these awards are given below, and a list of all the awards reported as being received in FY 2001 appears in Appendix F.

Leading the list of award-winning Web sites was the Chandra X-ray Observatory's Web site *http://www.chandra.harvard.edu/.* The Chandra site received over a dozen Web awards, including the Awesome Library Editor's Choice, the Busy Educator's Award, and the Griffith Observatory Star Award. The formal education community gave the Chandra Web site strong endorsements through an Eisenhower National Clearinghouse Digital Dozen Award and by designating it as a National Science Teachers Association (NSTA) *sciLINK* site. CPSnet Web Awards gave a High In The Sky Gold Seal to the Chandra Web site, noting that the site "presents an undeniable excellence . . . making it worthy of being publicly designated as an example to be followed and as a true knowledge and information source."

The Space Infrared Telescope Facility (SIRTF) Web site at *http://sirtf.caltech.edu/* was distinguished by the glowing accolades it received in FY 2001 from both the professional science and the professional education communities. From professional science societies, it received the American Association for the Advancement of Science Award of Excellence, and it also received citations from the American Physical Society and the Astronomical Society of the Pacific. From science publishers and broadcasters, it received a Citation for Excellence from *Sky and Telescope* magazine, a recommendation from the National Academy Press, and a listing as a Hot Site by Science News Radio. From the education community, it received the U.S. Department of Education's Educational Excellence Award and also an award from the Los Angeles County Office of Education. These awards show unambiguously that SIRTF is succeeding in presenting the science from its mission in a way that both meets the needs of educators and is endorsed by the science community.

The award-winning SIRTF Web site allows visitors to explore the uses of visible and infrared images.

Presenting the technology aspects of space science missions in a way that meets the needs of educators is one of the primary areas of emphasis of *Space Place*, the E/PO element of the New Millennium Program's technology development missions. Recognition that *Space Place* is succeeding in its work came in the form of a Presidential Citation from the International Technology Education Association for "efforts above and beyond the call of duty in service to the Technology Education profession." This major award received from a prominent professional education organization is a clear indicator that OSS is doing work of value to the education community.

Space Place displays, such as this one at the Blakemore Planetarium in Midland, TX, can be seen at hundreds of small museums across the country.

Evidence that OSS E/PO efforts are an increasingly important part of NASA activities came in the form of a number of major NASA awards given in FY 2001 for significant E/PO efforts. NASA Headquarters gave a NASA Group Achievement Award to the Space Science Education Resource Directory development team from the NASA Sun-Earth Connection and the Astronomical Search for Origins Education Forums. NASA Jet Propulsion Laboratory gave Awards for Excellence to Ms. Kay

After spending a week at NASA Goddard Space Flight Center, *SUNBEAMS* students create Web pages describing their experiences.

Ferrari for her leadership of the *Solar System Ambassadors* and *Solar System Educators* Programs and to the *Space Place* team for their work on the *Space Place* Web site. A NASA Group Achievement Award was also given for the *Cassini Microwave Observing Project*. NASA Goddard Space Flight Center (GSFC) gave a NASA Outstanding Leadership Medal to Dr. Richard Vondrak, co-Director of the Sun-Earth Connection Education Forum, for his "outstanding leadership in the development of new scientific programs and innovative approaches to education and public outreach." The NASA Sun-Earth Connection Education Forum itself received from GSFC a NASA Group Achievement Award recognizing its "superior efforts in making NASA's Sun-Earth Connection science known and understood nationally both in the classroom and to the general public." Finally, GSFC awarded a NASA Exceptional Service Medal to Dr. Carol Jo Crannell for her pivotal role in creating and advancing the highly successful *SUNBEAMS* program that brings the excitement of NASA space science to sixth grade students and their families in the District of Columbia Public Schools.

On a more local level, the economic impact of space science E/PO activities was recognized by a Targeted Industries Growth Report (TIGR) Award presented to University of Hawaii at Hilo faculty members Drs. Richard Crowe and Alice Kawakami. This award, presented by City Bank and published in *Hawaii Business* magazine, recognizes individuals and companies in emerging growth industries. Drs. Crowe and Kawakami received the award for their efforts to promote astronomy education in Hawaii through their *New Opportunities through Minority Initiatives in Space Science (NOMISS)* project under the NASA *Minority University Education and Research Partnership Initiative in Space Science*. A major thrust of *NOMISS* is to provide local youths with the training necessary to be employed as astronomers or technicians at the many major astronomical observatories in Hawaii.

". . . stunning, provocative and professional . . . . We look forward to working with you to make the images provided . . . an integral part of our new expanded exhibit on space exploration."

—North Museum of Natural History and Science, Lancaster, PA

ViewSpace gives museums and planetariums—particularly small ones—an opportunity to show continuously updated images from Hubble Space Telescope (HST) and other NASA space science projects in their galleries.

SCIENCE CENTER SHOWS/EXHIBITS

Science centers, museums, and planetariums provide particularly important venues for using the results of NASA space science missions to improve the public understanding of science and technology. In FY 2001, OSS provided materials, technical expertise, and other resources for use in exhibits, planetarium shows, displays, and education projects at more than 300 science centers, museums, and planetariums in 45 States, the District of Columbia, and the U.S. territories of Guam and Puerto Rico. Examples of some of the more visible outcomes from these contributions, including the unique *ViewSpace* network of museum displays intended for smaller institutions and several major traveling exhibitions featuring NASA space science missions, are described below. Detailed descriptions of these and other OSS projects with science centers, museums, and planetariums appear in Appendix A.

In an effort to give museums and planetariums—particularly small ones—an opportunity to show continuously updated images from Hubble Space Telescope (HST) and other NASA space science projects in their galleries, the Space Telescope Science Institute (STScI) has developed a multimedia astronomy display called *ViewSpace*. A museum or planetarium that wants to use *ViewSpace* provides an exhibition area with a PC, a display device (large monitor, LCD projector, or plasma screen), a small sound system, and an Internet connection. STScI then provides the *ViewSpace* astronomy exhibition content. *ViewSpace* presentations orchestrate high-resolution images, digital movie clips, nocturnal space music, and minimally intrusive text. *ViewSpace* is currently being distributed via CD, but it will soon transition into an Internet distribution model that will allow automated delivery of new content onto remote playback machines without any intervention on the part of the users. There are also plans to extend the *ViewSpace* content to include other NASA space science missions in addition to HST. Typical of the small museum community's reactions to *ViewSpace* were the North Museum of Natural History and Science in Lancaster, PA's comments that *ViewSpace* is ". . . stunning, provocative and professional . . . . We look forward to working with you to make the images provided . . . an integral part of our new expanded exhibit on space exploration."

Hardware from HST, including the HST backup mirror and instruments removed from HST by astronauts during servicing missions, form the centerpiece of *Explore the Universe*, a new permanent exhibition at the Smithsonian National Air and Space Museum that opened in September 2001. The gallery showcases some of the most significant observational tools astronomers have devised over the past four centuries, as well as the role each has played in our continuing quest to understand the universe. Visitors to *Explore the Universe* pass through five sections representing the evolution of the astronomer's instruments. In the final section, "Exploring the Universe with Spectroscopy," visitors encounter the HST mirror and instruments, as well as NASA space astronomy hardware from other missions such as the Hopkins Ultraviolet Telescope and the Chandra X-ray Observatory. The HST mirror and these other historic pieces of astronomy hardware will now be seen by millions of visitors each year as the capstone of four centuries of human endeavors to create astronomical instruments.

The *Space Weather Center*, a 700-square-foot exhibition that shows visitors how space weather phenomena—disturbances in the Sun's atmosphere that affect Earth's environment—play a role in their everyday lives. It continued its national tour in FY 2001 with stops at the Maryland Science Center, the NASA Goddard Space Flight Center visitor center, the Lawrence Hall of Science, and the Adler Planetarium and Science Museum. The *Space Weather Center* incorporates a number of interactive displays together with graphics of the Sun and aurorae and near-real-time data from NASA missions currently studying the Sun and near-

The Hubble Space Telescope backup mirror forms the centerpiece of the Smithsonian National Air and Space Museum's new Explore the Universe gallery.

Earth space environment. Museums that rent or purchase the exhibition join the Space Weather Museum Network (SWMN) and receive educational and public relations materials, access to public talks by space weather scientists, and opportunities for networking with other SWMN museum sites. The exhibition was developed through a partnership led by the Space Science Institute that included several of NASA's Sun-Earth Connection missions and research programs, the National Science Foundation, and a number of commercial vendors.

The *Hubble Space Telescope: New Views of the Universe* exhibition also continued its national tour in FY 2001. This exhibition invites visitors to explore the cosmos through the eyes of Hubble Space Telescope. Using activities, video, artifacts, and vivid Hubble images, they learn about the telescope's history, design, and purpose, as well as gain a greater understanding of planets, stars, galaxies, and the universe. A large-format poster book has been released to accompany the exhibition, and each venue hosting the exhibition also receives a discovery trunk filled with educational materials for classroom visitors. A large, 5,000-square-foot version of the exhibition was on display during FY 2001 at Space Center Houston in Houston, TX, the Strategic Air and Space Museum in Ashland, NE, and the North Carolina Museum of Natural Sciences in Raleigh, NC. A smaller, 2,000-square-foot version of the exhibition visited the Castle Museum in Saginaw, MI, the Springfield Science Museum in Massachusetts, the Family Museum in Bettendorf, IA, and the Chabot Space and Science Center in Oakland, CA. *New Views of the Universe* was developed through collaboration between the Space Telescope Science Institute and the Smithsonian Institution Traveling Exhibition Service.

On December 31, 2000, the 4,500-square-foot *MarsQuest* exhibition concluded its opening run at the McWane Science Center in Birmingham, AL, and embarked on a national tour with stops at the Orlando Science Center in Florida and the Tucson Children's Museum in Arizona. *MarsQuest* is organized around three important locations on Mars: 1) Olympus Mons, the largest volcano in the solar system; 2) Valles Marineris, a canyon as long as the United States is wide; and 3) Ares Vallis, the Pathfinder landing site. Each area makes comparisons between Mars and Earth, giving visitors a real sense of the Martian environment. *MarsQuest* visitors encounter more than 20 interactive experiences, four life-size models, and dramatic artwork of Martian landscapes. Visitors can send commands to maneuver a rover over a simulated Martian landscape, among many other engaging hands-on opportunities. Additional components of the *MarsQuest* program include a 30-minute planetarium show from Loch Ness Productions narrated by actor Patrick Stewart, best known as Captain Picard of the TV program *Star Trek, The Next Generation*, and a *MarsQuest* Education Program that provides on-site, full-day workshops for museum staff and teachers. *MarsQuest* was developed by the Space Science Institute. A substantial number of OSS-supported Mars scientists were involved in the planning, development, and evaluation of this exhibit.

"Our members provided information on the eclipse event and generated excitement, wonder, and appreciation for science in underrepresented minorities."

—Dr. Charles McGruder, President, National Society of Black Physicists

National Society of Black Physicists scientists interpret the June 21, 2001, solar eclipse broadcast/Webcast for students assembled at NASA Glenn Research Center.

TARGETED OUTREACH

Targeted outreach projects are those that emphasize meaningful participation in OSS activities by individuals from groups that are currently underserved and underutilized in science and technology. These projects are motivated by the recognition that meeting the future needs of a society based on science and technology requires the involvement of all Americans. While all OSS E/PO projects are encouraged to include underserved and underutilized groups among their participants, several examples of FY 2001 projects that made such involvement their primary focus are given below. Descriptions of these and other such projects may be found in Appendix A.

A major new OSS focus in FY 2001 was forming working relationships with a network of professional societies of minority scientists. The goals were to engage the society members as consultants and partners for broadening the diversity of participants in OSS missions and E/PO projects and to improve the effectiveness of OSS support for activities of the professional societies. After an initial get-acquainted session with officers from five such societies at the December 5–7, 2001, OSS Education Council meeting in Galveston, TX, a working follow-up meeting on May 9–10, 2001, at Western Kentucky University brought the officers of 11 professional societies of minority scientists together with members of the OSS E/PO Support Network to explore potential collaborative projects. The societies involved in this effort, including one that joined the group during a follow-up teleconference, are as follows:

- the American Indian Science and Engineering Society;
- the Coalition to Diversify Computing;
- the Council for African-American Researchers in the Mathematical Sciences;
- the Institute for African-American e-Culture;
- the National Association for Black Geologists and Geophysicists;
- the National Association of Mathematicians;
- the National Institutes of Health Black Scientists Association;
- the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers;
- the National Society of Black Physicists;
- the National Society of Hispanic Physicists; and
- the Society for the Advancement of Chicanos & Native Americans in Science.

A prime example of the type of outcomes expected from this effort over the long-term was the partnering of the National Society of Black Physicists (NSBP) with the NASA Sun-Earth Connection Education Forum (SECEF) in planning and implementing a national effort to establish local sites in African American communities for viewing a live broadcast/Webcast of the June 21, 2001, total solar eclipse from Africa. More than 20 NSBP members served as hosts and science experts at these sites where, in the words of NSBP president Dr. Charles McGruder, they "provided information on the eclipse event and generated excitement, wonder, and appreciation for science in underrepresented minorities."

Minority institutions of higher education continued to play an important role in OSS efforts to provide space science opportunities for underserved/underutilized groups. In FY 2001, 15 minority universities, including six Historically Black Colleges and Universities (HBCU), three Hispanic Serving Institutions (HSI), and three Tribal Colleges (TCU), began work under the *Minority University Education and Research Partnership Initiative in Space Science*. This initiative, developed in partnership with the NASA Office of Equal Opportunity Programs (OEOP), offers minority universities an opportunity to develop academic programs and/or faculty and student capabilities in space science through close partnerships with major OSS space science research groups.

The progress made during FY 2001 by the 15 participating minority institutions was remarkable. They established a total of eight new space science faculty positions and redirected

Students from York College of the City University of New York learn firsthand about studying the universe from Professor James Peebles of Princeton University.

10 previously existing faculty positions towards space science. They offered or were developing a total of 32 new and 13 revised undergraduate or graduate space science courses, and they established or were developing one new space science major and nine new space science minors. They conducted a wide variety of space science teacher training and public outreach activities, and they greatly enhanced the space science capabilities of the participating minority institution faculty members and students by initiating more than 30 working partnerships with major space science research groups at NASA Centers, universities, research laboratories, and observatories across the country. Included in these partnerships was minority institution involvement in seven space science missions or suborbital experiments funded by or proposed to OSS.

One example of the activities conducted under this minority university initiative is Norfolk State University's (NSU) *NASA-HBCU Partnership to Enhance Minority Education and Research Participation in the Space Sciences*. NSU space science research capabilities were enhanced through establishing a collaboration with the NASA Goddard Space Flight Center (GSFC) Laboratory for High Energy Astrophysics (LHEA). NSU became a member of LHEA's Balloon Borne Experiment Superconducting Solenoid magnet (BESS) experiment team, and NSU faculty members began analysis of cosmic ray data from BESS. NSU contributed to space science education in the Hampton Roads area by developing and teaching two courses that provided hands-on astronomical activities for in-service high school teachers. To support the classes, NSU initiated plans to acquire small telescopes and a CCD camera and to build a university-funded, on-campus astronomical observatory. Public outreach was being conducted through the NSU Planetarium. The Planetarium underwent a major overhaul that included total refurbishment of the star projector and the addition of new multimedia equipment. New shows were being developed for the general public, and, in collaboration with GSFC and the Maryland Science Center in Baltimore, a cosmic rays planetarium show was being planned for national distribution.

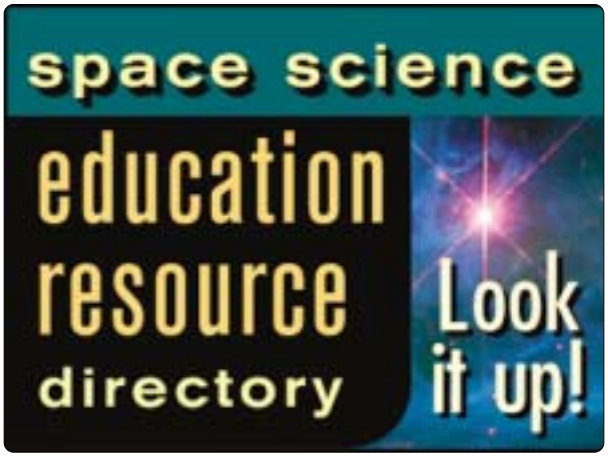
A visually impaired student experiences a tactile image of Jupiter prepared for *Touch the Universe: A NASA Braille Book of Astronomy*.

OSS's work to reach underserved/underutilized groups in FY 2001 was not restricted to minorities and minority universities. For example, in an effort to serve students with special needs, *Touch the Universe: A NASA Braille Book of Astronomy*, that makes the magnificent images taken by the Hubble Space Telescope (HST) accessible to visually impaired students, was developed. *Touch the Universe* contains 14 spectacular HST images, each printed in color and supplemented by a transparent tactile overlay in which the color features are represented by tactile symbols. Accompanying explanatory text is given in both braille and large print so that readers of all visual abilities are able to view and read the book together. Through these images, the reader is taken on a journey of discovery to more and more distant objects, starting with images of the telescope itself in orbit and ending with the HST Deep Field image of some of the most distant galaxies in the universe. The book was showcased during a press conference at the June 2001 American Astronomical Society meeting in Pasadena, CA. At the close of FY 2001, plans for large-scale publication and distribution were being discussed with a number of national organizations such as the National Academy of Sciences Press and the National Federation of the Blind. The impetus and funding for the project came through an E/PO supplement award to an HST Guest Observer grant held by Dr. Bernhard Beck-Winchatz of DePaul University, in collaboration with noted braille book author Noreen Grice. This effort is also a prime example of how a relatively small amount of money can be used to develop a national product when care and thought are taken to identify a unique need. Further information about *Touch the Universe* is available at *http://analyzer.depaul.edu/ttu*

The real beneficiaries of targeted outreach activities such as the ones highlighted here are not only the faculty, students, and institutions involved, but also OSS and the Nation. As is emphasized in the Space Science E/PO Implementation Plan, "meeting the future needs of a society based on science and technology will require the involvement of individuals from groups who, at the current time, are not as effectively utilized as they should be in science and technology. This is an urgent matter of national self-interest, not a matter of 'political correctness.' The issue is not just one of ensuring the future supply of scientists and engineers. It also involves the need to educate all people about the important role that science and technology plays in their lives."

". . . a dedicated, demanding, and innovative effort to successfully develop an important new educational resource for use by students and teachers across the country."

—NASA Group Achievement Award Citation



The Space Science Education Resource Directory gives educators access to a wide variety of OSS E/PO materials.

EDUCATIONAL PRODUCTS

Providing educational products that use space science missions and discoveries to enhance what is taught in the classroom is a major facet of the OSS E/PO Program. During FY 2001, considerable effort was put into making these products more readily accessible to teachers and to giving enhanced guidance as to their usefulness in the classroom.

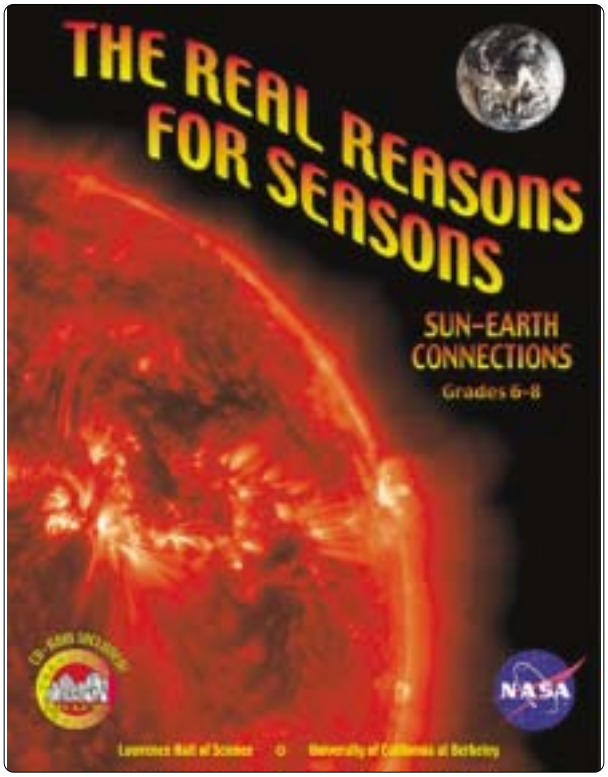
The heart of the effort to provide easy access to OSS-developed educational materials is the Space Science Education Resource Directory. Located at *http://teachspacescience.org*, the Resource Directory is an online repository of OSS educational resources. Educators seeking materials can easily search the Resource Directory by keywords, browse the directory by topics, or conduct advanced searches using any combination of keywords, grade levels, formats, and subjects. The Resource Directory is compatible with and linked to national educational databases such the U.S. Department of Education's Gateway to Educational Materials (GEM) that are familiar to and widely used by teachers. During its first full year of operations, the response of the education community to the Resource Directory was very enthusiastic. The effort to develop it was recognized with a NASA Group Achievement Award presented to the Resource Directory development team, a collaborative of the NASA Sun-Earth Connection and Origins Education Forums, for "a dedicated, demanding, and innovative effort to successfully develop an important new educational resource for use by students and teachers across the country."

One main objective of the Resource Directory is to become a one-stop shopping site for space science materials. It is critical to ensure that educators not only can find materials in the Resource Directory, but that they also can easily obtain those materials for their own use. In the FY 2001 release of the Resource Directory, only those resources that were available electronically over the Internet were included. For such items, the Resource Directory gives users a link either to the resource's own Web site or to a downloadable Portable Document Format (PDF) file. During FY 2001, efforts were begun to develop means by which educators would also be able to order hardcopy materials online from the Resource Directory. A partnership was made with the NASA Central Operation of Resources for Educators (CORE), through which Resource Directory users would be able to place online orders for OSS multimedia educational materials (e.g., videos, CDs, or slides) for mail distribution by CORE for a minimal fee. Steps were also taken to begin acquiring one or more commercial partners to provide similar services for printed materials.

Another objective of the Resource Directory is to give educators some guidance as to the quality and utility of the many resources contained within it. To this end, a pilot OSS product review was held during FY 2001. Approximately 60 OSS products, representing each of the four OSS theme areas, were evaluated and rated by panels of scientists and educators. Products given an exemplary rating by the review panels received an official NASA OSS Seal of Approval within the Resource Directory. The seal informs users that a particular product has been reviewed for both science accuracy and pedagogy and has been rated as a superior resource.

At the end of FY 2001, there were nearly 300 space science products registered in the Resource Directory. Approximately 200 of these products were available electronically over the Internet and, therefore, are accessible to searches by Resource Directory users. The other approximately 100 products were available only as hardcopy materials and, therefore, will not be accessible to searches by Resource Directory users until the hardcopy distribution mechanisms are in place. Appendix A of this Annual Report contains descriptions of the more than 90 new educational products that were registered in the Resource Directory during FY 2001. Readers interested in obtaining any of these products should visit the Resource Directory at *http://teachspacescience.org* for access to those products that are currently available for widespread distribution.

One example of the products developed in FY 2001 is *The Real Reasons for Seasons: Sun-Earth Connections* teacher's



The Real Reasons for Seasons: Sun-Earth Connections teacher's guide was issued as part of the award-winning Great Explorations in Math and Science (GEMS) series.

guide that was issued as part of the award-winning Great Explorations in Math and Science (GEMS) series. The guide is targeted to middle school teachers and is the first in the GEMS series to include an accompanying CD-ROM. Developed by the NASA Sun-Earth Connection Education Forum in collaboration with the Lawrence Hall of Science, the guide contains activities to help teachers dispel common misconceptions about Earth's seasons and other Sun-Earth connection issues. The CD-ROM contents include complementary materials featuring Sun-Earth Connection NASA resources. The *Seasons* GEMS guide will be distributed nationally through the existing network of GEMS sites, where training for local teachers will be provided. GEMS guides are also distributed through the National Science Teachers Association *Science Store*. Currently, GEMS guides are used collectively in approximately 25 percent of the country's school districts. OSS, working in isolation, would have no hope of achieving such widespread distribution of its products. This is another example of the reason why collaborations with organizations like the Lawrence Hall of Science are so central to the implementation of the OSS E/PO Program.

"The health of the U.S. economy, therefore, will depend not only on professionals who can produce and direct innovation in a few key areas, but also on a populace that can effectively assimilate a wide range of new tools and new technologies."

—The Commission on National Security in the 21st Century

Teachers enjoy exploring volcanic layering at an educators' workshop held in conjunction with the *MarsQuest* exhibition.

EDUCATIONAL ACTIVITIES

In FY 2001, OSS sponsored more than 160 educational activities that directly supported classroom education at the precollege level, and over 90 educational activities directed at reaching the public. Through these two areas, OSS contributed both to motivating and training the future scientific workforce and to improving the general public's understanding of science and technology. OSS also sponsored a number of activities that were aimed at encouraging members of the space science community to contribute to E/PO activities and at improving the effectiveness of their participation. Through these programs, OSS-affiliated scientists, technologists, and support personnel interacted directly with nearly 200,000 teachers, students, and members of the public. In addition, more than 50 million people participated in such activities over the Internet, and an estimated potential audience of more than 200 million people was reached through large public events, exhibits, periodicals, and media broadcasts. Further comments on and examples of some highlights of these educational activities are given below, and detailed descriptions of each such activity appear in Appendix A.

Numerous workshops for teachers were conducted by the E/PO elements of OSS flight missions and research programs in FY 2001. These workshops offered teachers the opportunity to experience some of the excitement of conducting space science flight missions. They also helped to increase the teachers' understanding of the discoveries made by such missions and research programs. In many cases, teacher's guides and classroom activities based on the missions or programs were provided as part of the workshop. The subject areas covered a wide range of topics. For example, the NASA Astrobiology Program's *Living in the Microbial World* workshop examined microbial diversity and the evolution of some of the earliest ecosystems on Earth. The Stratospheric Observatory for Infrared Astronomy (SOFIA) mission's *Astronomy at 41,000 Feet* workshop examined the nature of infrared light, the research to be conducted by SOFIA and by the Space Infrared Telescope Facility (SIRTF), and the contributions they are expected to make to our understanding of the evolution and origin of the universe. The Solar-B mission's *Touch the Sun* workshop introduced teachers to an experiment-based curriculum in which students design, build, and use six different Sun-and-light-observing instruments, ranging from classic instruments like sundials and pinhole cameras to modern instruments such as spectrographs and polarimeters.

Many workshops took place at major national educators' conferences such as the National Science Teachers Association (NSTA) meeting in St. Louis, the National Council of Teachers of Mathematics (NCTM) meeting in Orlando, and the International Technology Education Association (ITEA) meeting in Atlanta. Typically, these workshops were presented in conjunction with a major OSS E/PO exhibit booth, where teachers could examine materials and discuss them with the OSS staff present at the booth. Teacher workshops were also conducted at regional educators' conferences, at museums and science centers in conjunction with major OSS exhibitions, and at numerous other venues throughout the country.

Direct contact with OSS flight missions and research programs for students were provided by activities such as the *Goldstone Apple Valley Radio Telescope (GAVRT)* project. *GAVRT* is a partnership between the NASA Jet Propulsion Laboratory (JPL) and the Lewis Center for Educational Research in Apple Valley, CA. In this project, thousands of 5th to 12th grade students across the country, working over the Internet from their classrooms, assumed command of a decommissioned 34-meter NASA antenna from the Deep Space Network. During FY 2001, the research projects conducted by *GAVRT* students using this radio telescope included the following: measuring radio emissions from

The *GAVRT* project allows students, such as these at Redlands East Valley High School in California, to conduct research projects by remotely controlling a decommissioned 34-meter NASA antenna.

Jupiter to support calibration of the Cassini mission's onboard radar instrument receiver (the *Cassini-Jupiter Microwave Observing Campaign*); taking radar data of the Schiaparelli Crater on Mars to support the Mars Exploration Program's search for possible future landing sites on Mars; and monitoring the intraday, variable quasar 0917+624 as part of a radio astronomy project being carried out in Australia. Through these projects, the *GAVRT* students were able to use real, NASA-unique research equipment to experience the thrill of contributing to actual research results. In the case of the *Cassini-Jupiter Microwave Observing Campaign*, for example, 40 teachers worked with 2,300 students at 26 schools in 13 States to obtain the measurements.

A partnership between NASA and Geoff Haines-Stiles Productions, Inc., has led to a well-received set of programs featuring NASA space science missions. The *Passport to Knowledge (P2K)* series is a set of interactive learning adventures connecting science concepts with exciting real-world phenomena. Each *P2K* program consists of an integrated suite of live broadcasts, video programs, hands-on activities, and online resources that allow students to experience some of the most exciting and challenging places on Earth and beyond. During FY 2001, two new programs, *Live From a Black Hole* and *Live From the Edge of Space and Time*, were broadcast. In both programs, researchers from the Chandra X-Ray Center (CXC) at the Harvard-Smithsonian Center for Astrophysics participated in taped and live sequences explaining how X-rays allow us to see the invisible, as well as how to transform speculation about black holes, quasars, and the scale and structure of the Universe into scientific study and relate it to the physics found in the core science curriculum. Both programs aired over Public Broadcasting System stations and NASA-TV. Collaboration with the NASA Structure and Evolution of the Universe Education Forum and the Gamma-ray Large Area Space Telescope (GLAST) and Swift missions resulted in a set of updated hands-on educational activities that were published online and demonstrated on camera by enthusiastic CXC researchers. Also during

The total solar eclipse of June 21, 2001, was broadcast/Webcast live from Sausage Tree Camp in Zambia, Africa, by staff from the Exploratorium and the NASA Sun-Earth Connection Education Forum.

FY 2001, preparations were made for the *Live From Mars* broadcasts in this series, scheduled to originate from JPL on October 31, 2001, and from JPL and the Mars Imaging Facility at Arizona State University on March 19, 2002, as the Mars Odyssey mission continued to unfold.

Direct outreach to the public was accomplished in FY 2001 through activities such as the *Live from Africa—Solar Eclipse 2001* broadcast and Webcast of the June 21, 2001, total solar eclipse. A team of scientists and educators from the NASA Sun-Earth Connection Education Forum and the Exploratorium in San Francisco went to Zambia to witness the eclipse and to broadcast it live via satellite and over the Internet. In addition, special live events were conducted in collaboration with over 160 museums, planetariums, and other venues to allow the public to witness the event. During those events, more than 70 space scientists served as hosts at local sites, helping to educate audience members about the sun and its impact on Earth. Audience members were also treated to a conversation about solar radiation in space with astronauts Jim Voss and Susan Helms who were aboard the International Space Station. Among the local hosts were more than 20 members of the National Society of Black Physicists, who made a special effort to bring the event to minority communities and minority youths. Among the local audiences were nearly 70 Girl Scout troops. In total, the special programs and the Webcast reached a confirmed audience of over 400,000 people, and the broadcast over NASA TV reached millions of additional people.

Large public audiences were also reached by JPL's *Space Place* Program. *Space Place* used an anchor Web site at *http://spaceplace.nasa.gov* to offer computer and real-world interactive experiences and information for children and adults on space exploration and Earth observation, with an emphasis on the technology-driven missions of NASA's New Millennium Program. *Club Space Place* provided display materials and quarterly hands-on activity guides to over 250 partners that included the Boys and Girls Clubs of America, the YWCA, the Civil Air Patrol, and museums, planetariums,

Participants engage in the "Change Game," a simulation of school district education reform during the Space Science Institute's Annual K–14 Education Workshop for Scientists, Engineers, and Education and Public Outreach Professionals.

and libraries in rural areas of the country. *Space Place* also provided regular articles on science and technology subjects for *The Technology Teacher* magazine of the International Technology Education Association (ITEA), with an estimated readership of 8,000 teachers. The *Kids' Reading Room* column from this magazine also appeared in newspapers, including the *Denver Post* and the *Los Angeles Times*, and in the *Weekly Reader* newspaper which reaches more than seven million elementary schoolchildren in 50,000 schools. These types of numbers vividly illustrate the types of leverage possible through partnerships with organizations outside of NASA—one of the central principles of OSS's approach to E/PO.

OSS also recognizes the continuing need to encourage scientists' participation and to improve their effectiveness in E/PO activities. The fact that nearly 900 OSS-affiliated scientists, technologists, and support personnel contributed to OSS E/PO activities in FY 2001 (see Appendix C) is an impressive statement of the OSS community's commitment to education. Yet, these 900 dedicated individuals represent only a small fraction of the potentially available OSS community. Thus, during FY 2001, the OSS E/PO Support Network provided exhibits and/or conducted workshops at a dozen major meetings of scientists which were aimed at increasing scientists' familiarity with OSS E/PO efforts and current educational practices. The Support Network's efforts also encouraged scientists to increase their participation in E/PO activities. The above-referenced meetings included those of professional societies such as the American Astronomical Society, the American Geophysical Union, and the Geological Society of America, as well as the annual Lunar and Planetary Sciences Conference (see Appendix E). In addition, more extensive workshops for scientists interested in E/PO were conducted by the NASA Johnson Space Center, the Space Science Institute, and DePaul University.

A joint meeting of the American Astronomical Society (AAS) and the American Association of Physics Teachers (AAPT) on January 7–11, 2001, in Pasadena, CA, offered a unique opportunity to promote the OSS E/PO Program both to research astronomers and high school physics teachers. The fact that the AAS and the AAPT had such a joint meeting was, in itself, a mark of the increased interest in education on the part of the astronomical community. A special exhibit highlighting the strategy of the OSS E/PO Program was displayed in the exhibit hall. As part of the exhibit, an interactive computer station allowed visitors to explore the OSS Space Science Education Resource Directory and the FY 2000 OSS E/PO Annual Report. The first OSS E/PO newsletter was also distributed. In addition, more than 100 OSS-sponsored papers were presented at this meeting, dealing with various aspects of the OSS E/PO Program. Presenting such an array of papers would have been inconceivable even just a few years earlier.

"OSS must be able to examine the progress being made in the implementation of its entire education and outreach program. The effectiveness of the total system as well as individual pieces must be considered. For this purpose, a broad perspective will be required."

—Implementing the Office of Space Science (OSS) Education and Public Outreach Strategy (October 1996)

EVALUATION

As should be evident from the contents of this Annual Report, the E/PO-related policies that OSS has implemented over the past several years have generated an enormous amount of activity. While saying that we have produced so many products—and involved so many hundreds of people in conducting thousands of events across the country—tells us much about the level of activity, it says little about the effect of all this work. And producing a large number of poor-quality educational products would probably be worse than producing none at all. For these reasons, OSS has made evaluation a central element of all its work.

To date, three substantive steps have been taken to assess the quality, effectiveness, and impact of the OSS E/PO Program. First, as noted earlier, OSS has instituted a formal product review process, and a pilot review was held in FY 2001. The results of those reviews will be incorporated into the Space Science Education Resource Directory and will be fed back directly to product developers to improve the quality of their products.

Second, since late 1998, OSS has been working closely with the Program Evaluation and Research Group (PERG) at Lesley University in Cambridge, MA, which is serving as an independent external evaluator. PERG efforts, to date, have focused primarily on issues associated with the effectiveness of the OSS E/PO Support Network during its formative period and with the progress being made by OSS toward realizing its E/PO goals. The second phase of the work was completed at the end of FY 2001. The resulting report may be found at *http://spacescience.nasa.gov/education* by clicking on the "evaluation" link. Many of PERG's findings, together with feedback from both the space science and education communities given directly to OSS or received through the Support Network members, have, in fact, already led to significant changes in a number of OSS processes—particularly in the way that E/PO is handled in NASA Research Announcements.

Third, OSS has established a formal task force under the NASA Space Science Advisory Committee in order to assess how well OSS has succeeded in implementing its E/PO Implementation Plan—which is the foundation of its whole approach to education. This Task Force will also consider whether any significant changes in process, content, or direction are needed.

A potential future scientist shows off the Genesis mission tattoo and hand stamp she received at a NASA Jet Propulsion Laboratory open house.

"A major national program in space science education is now underway. But what is going on today represents just a hint of the program that is already in the pipeline."

—Jeffrey D. Rosendhal
Education and Outreach Director
Office of Space Science

Visitors to the National Capitol Mall encounter *Voyage*, one-ten-billionth scale model of the solar system.

SUMMARY AND FUTURE PLANS

FY 2001 was a year of tremendous progress for the OSS E/PO Program. The policy of requiring every space science mission and program to engage in E/PO activities continued to generate hundreds of projects taking place in every corner of the Nation. The OSS E/PO Support Network has clearly developed into an extremely active and productive body. The partnerships, formed with hundreds of educational institutions and organizations, science centers and planetariums, minority communities, and research institutions across the country, clearly leveraged OSS E/PO resources far beyond all expectations. The OSS E/PO Program is already reaching millions of people, but all of these activities give just a taste of the many new directions that will be explored over the next few years.

At the close of FY 2001, a number of major activities were planned to be continued or completed in FY 2002. *Voyage*, an accurate, one-ten-billionth scale model solar system developed by the Challenger Center for Space Science Education in Alexandria, Virginia, in collaboration with NASA and the Smithsonian Institution, was scheduled to open on the National Mall in Washington, DC, on October 17, 2001. *Cosmic Questions: Our Place in Space and Time*, a 5000-square-foot traveling exhibition developed primarily through a partnership between the NASA Structure and Evolution of the Universe (SEU) Education Forum and Boston's Museum of Science, will invite museum visitors of all ages to join the ongoing quest to understand the universe and our place in the cosmos. Scheduled to open in the fall of 2002, this exhibit involves nearly every SEU mission and represents an effort by that community to bring to the public some of the most exciting and challenging issues in contemporary astronomy.

Efforts to reach out to an ever-increasing range of audiences will continue. Relationships with groups such as the Girl Scouts, 4-H Clubs, and other community organizations will continue to be developed. Additional partnerships with members of professional societies of minority scientists will be sought, and the possibility of releasing in FY 2003 a new call for proposals to expand the NASA *Minority University Education and Research Partnership Initiative in Space Science* will be explored. Plans for large-scale publication and distribution of *Touch the Universe: A NASA Braille Book of Astronomy* will continue to be developed, and new possibilities for developing materials directed at children with special learning needs will be explored.

The Space Science Education Resource Directory will be continually expanded and upgraded with new products and with the incorporation of new capabilities—the most important of which is providing users with the ability to place online orders for the hardcopy materials that will eventually be included in the Resource Directory, when a mechanism for reproduction and distribution of these materials has been established. Provisions for routine review and evaluation of materials in the Resource Directory will also be put in place. Major new products both in print and online will continue to be developed. Among them is a new volume on *Living with a Star* that was scheduled to be added to the Great Explorations in Math and Science (GEMS) series in Spring 2002. A new multimedia kit, *Seeing and Exploring the Universe!*, which explains how each SEU mission sees and explores the universe, was scheduled to be available in March 2002.

OSS's participation in systemic improvement initiatives will increase through a new focus on working in urban areas and through a partnership with the NASA Education Division's *Linking Leaders* Program. *Linking Leaders* brings together educational leaders in each State with NASA representatives to identify effective approaches by which NASA resources and materials might be integrated into State systemic initiatives for improving science, math, and technology education. Beginning in FY 2002, the OSS Broker/Facilitators will be regular participants in *Linking Leaders* meetings and activities in all States in which a *Linking Leaders* Program is in place.

Annual Sun-Earth Days are national celebrations of the Sun and its interactions with the Earth.

We will continue to use both Public Television and the Internet as vehicles for reaching large audiences. Work will continue on the *Passport to Knowledge* series, with two programs about Mars already scheduled for FY 2002, and additional broadcasts on aurorae, multiwavelength astronomy, and astrobiology are planned for FY 2003–2004. Discussions are also underway with another television producer to collaborate on a Public Television series on the origins of planetary systems and life, to be broadcast in FY 2004.

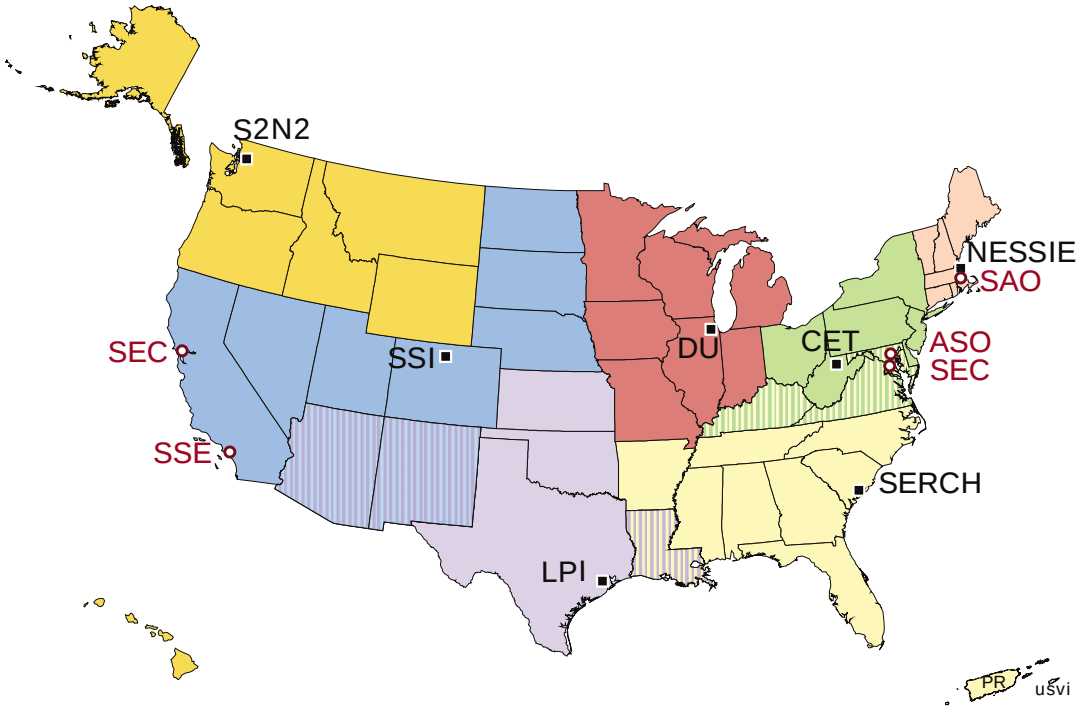
We will continue to use natural phenomena as vehicles for exploring basic issues in space science education. And so, for example, March 20, 2002, will be Sun-Earth Day, a national celebration of the Sun, the space around Earth (geospace), and how all of it affects life on our planet. Participating classrooms, museums, and planetariums across the country will be provided with Sun-Earth Day kits containing classroom activities and background material. A special focus will be placed on Native American connections with the Sun and the equinox.

The OSS E/PO Support Network will be substantially expanded in FY 2002 with the addition of three new Broker/ Facilitators who will focus on the Pacific Northwest, New England, and Mid-Atlantic regions of the country. Contact information for these new Broker/Facilitators, as well as for the rest of the OSS E/PO Support Network, can be found under the link to "Support Network" at *http://spacescience.nasa.gov/education/*

Evaluation will continue to be a major area of emphasis for OSS. PERG will extend its previous work into a third phase centered on looking for evidence of effectiveness and the impact of the OSS E/PO Program, as seen by the education community. The Space Science Advisory Committee E/PO Task Force will complete its fact-finding in FY 2002 and submit its recommendations to OSS in early FY 2003. The results of both efforts will be used to guide future program modifications and improvements.

With these and many other new projects planned for FY 2002 and beyond, the OSS E/PO Program looks forward to continued growth, continuous improvements in effectiveness and educational impact, and increasing efforts to reach nontraditional audiences. Within the education and the space science communities, awareness and recognition of the scope of the OSS E/PO Program continues to grow, and that awareness has triggered increasing interest in participating in the program by both space scientists and educators.

OSS is pleased to be making these contributions as an integral part of NASA's efforts to enhance the quality of science, mathematics, and technology education across the Nation and to increase the public's understanding of science and technology. We said at the outset that it would be "the total effect of a broad ensemble of high-leverage activities carried out over a long period of time which can make a difference." We have finally arrived at a sufficient state of maturity that we are beginning to actually make a difference.



○ Forums

- Astronomical Search for Origins and Planetary Systems (ASO)
  : Space Telescope Science Institute
- Structure and Evolution of the Universe (SEU)
  : Smithsonian Astrophysical Observatory
- Solar System Exploration (SSE)
  : Jet Propulsion Laboratory
- Sun-Earth Connection (SEC)
  : Goddard Space Flight Center
  : University of California at Berkeley

■ Broker/Facilitators

- Center for Educational Technologies (CET)
- DePaul University (DU)
- Lunar and Planetary Institute (LPI)
- New England Space Science Initiative in Education (NESSIE)
- Southeast Regional Clearinghouse (SERCH)
- Space Science Institute (SSI)
- Space Science Network Northwest (S2N2)

The OSS E/PO Support Network for 2002 consists of seven Broker/Facilitators and four Education Forums.